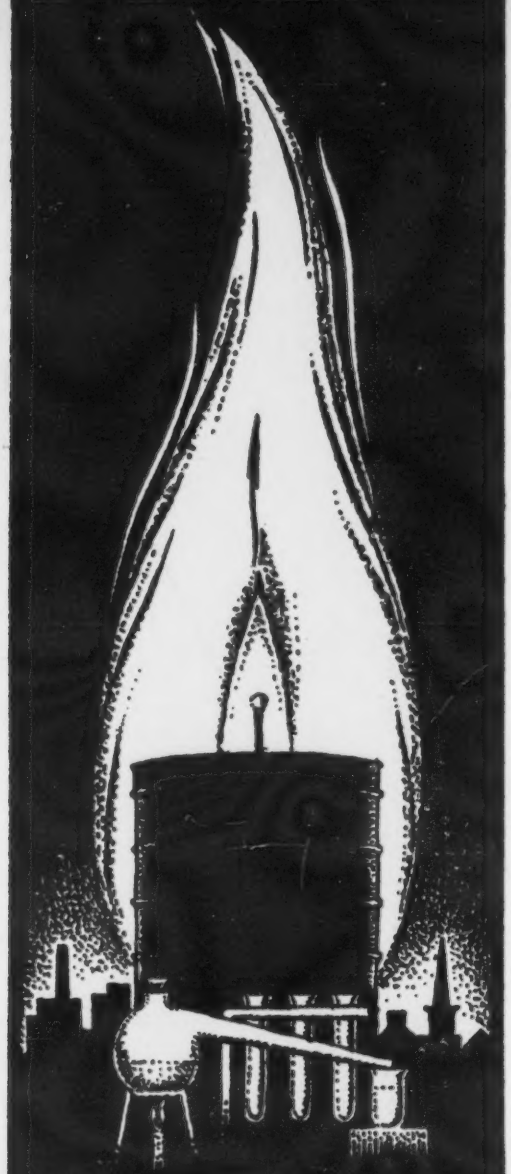

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GAS ABSTRACTS

GAS ABSTRACTS was started in 1945 by the Institute of Gas Technology to survey current technical journals, to select articles pertaining to the Gas Industry, and to prepare abstracts of these articles, stressing their significance to the Gas Industry.

Selection of Articles: Each month the periodicals listed on the last two pages are examined and articles pertaining to the production or manufacture, distribution, transmission or storage, and utilization of natural and manufactured gas and related subjects are selected for abstracting by individual staff members of the Institute of Gas Technology. When possible the significance of the article to the Gas Industry is stressed.

Classification of Abstracts: The abstracts are grouped under twelve headings for presentation and are arranged alphabetically by subject in each group. The headings and subject matter included in each are presented below:

1. The Gas Industry will include general information and news items, statistics, business regulations and other articles of general interest.

2. Appliances - Domestic and Commercial will include burners, ranges, cooking equipment, air conditioning equipment, water heaters and other gas appliances for domestic and commercial use.

3. Combustion and Industrial Furnaces will include combustion of gaseous, liquid and solid fuels; design of industrial furnaces; control of furnace atmospheres.

4. Carbonization and Gasification will include manufacture and purification of producer gas, blue gas, carburetted water gas, synthesis gas; carbonization and gasification of coal; and gasification of oil.

5. Natural Gas and Natural Gas Condensates will include production, transmission, distribution and storage of natural gas and natural gas condensates; distribution of LP-gas mixtures; carbon black and chemicals from natural gas and natural gas condensates.

6. Petroleum and Synthetic Liquid Fuels will include production, refining-cracking, alkylation, isomerization, and utilization of petroleum and production of synthetic liquid fuels by the Fischer-Tropsch reaction and hydrogenation.

7. Analytical Methods and Tests will include new and improved methods pertaining to gas making materials, processes, products, and by-products.

8. General and Physical Chemistry will include data on chemical and physical properties of elements and inorganic compounds; new reactions; and methods for carrying out established reactions.

9. Organic Chemistry will include data on organic compounds closely related to the Gas Industry; new reactions; new methods for carrying out established reactions.

10. Chemical Engineering will include data and methods for fluid flow, heat transfer, and unit operations of distillation, evaporation, extractive drying, and filtration.

11. Process Equipment and Instrumentation will include information on new equipment for process operations and process control.

12. Materials of Construction will include new developments in refractories, heat and corrosion resistant materials, new alloys applicable to the Gas Industry, and other materials of construction.

13. New Books will include recent books pertaining to the field of gas technology.

Annual Index: Author and subject indexes will be is ued at the end of the year.

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I. THE GAS INDUSTRY

CASINGHEAD GAS CONSERVATION

Pryor, C.C. CASINGHEAD GAS CONSERVATION. *Oil Weekly* 121, 56-62 (1946) *March 11.*

Humble Oil & Refining Company has announced a $4,783,000 program for additional conservation of 60,722,000 cubic feet per day of vented casing head gas in 11 fields in the Gulf Coast area of Texas. More than $1,900,000 has been spent by the company in an earlier program. Additional casinghead gas conservation programs have been planned for other areas in which Humble is operating. The policy of the company is in general accord with those engineering principles and recommendations of the Gas Conservation Engineering Committee appointed by the Texas Railroad Commission. This policy includes the principles of (1) completing and operating oil wells and oil reservoirs in such a manner as to result in a minimum production of casinghead gas and maximum efficient oil recovery, and (2) marketing, consuming, or returning to the producing reservoir the produced casinghead gas wherever such disposition is economically feasible.

HELIUM PRODUCTION

HELIUM PRODUCTION REVIEWED IN BUREAU OF MINES REPORT. *Chem. Eng. News* 24, 473 (1946) *February 25.*

Bureau of Mines plants in the last 5 fiscal years produced 370,787,000 cubic feet of helium. The largest portion of the 1941-45 production went to the United States Navy, but considerable volumes were supplied to the Army, the Weather Bureau for meteorological balloons, and to medical, scientific, and commercial users. The Bureau of Mines, since 1925 the sole government agency charged with helium production, operated extraction plants at Amarillo and Exell, Tex., Otis and Cunningham, Kans., and Shiprock, N. Mex., during the war. The Amarillo plant was supplied from the government-owned 50,000-acre Cliffside gas field and the Shiprock plant tapped a federally controlled gas field, while the other plants extracted helium from privately owned natural gas going to industrial markets. Four new helium-extraction plants were built and existing production facilities at Amarillo were expanded in 3 years under a $16,000,000 expension program launched soon after this country was forced into war.

--Excerpt from Article

MINERAL RESERVES

INTERIOR DEPARTMENT REPORT STRESSES MINERAL DEPLETION. *Chem. Eng. News* 24, 481 (1946) *February 25.*

The war indicated that our mineral reserves are inadequate to meet peak emergency demands, and it will be necessary to strengthen the country's position in that regard through advance planning, says former Secretary of the Interior Harold L. Ickes in his 1945 report to the President. Preparations of this kind, he believes, should include some provision for national stockpiles of strategic, critical materials. Looking still farther ahead to the day when auxiliary sources of oil and gas may be needed to fuel the motorized economy, the bureau was well on its way

toward the development of synthetic liquid fuels. With Congressional authorization, construction started on a laboratory at Bruceton, Pa., for research on the hydrogenation and gas synthesis processes of producing oil from coal, on a laboratory at Laramie, Wyo., to develop oil shale distillation processes, and on a demonstration plant at Rifle, Colo., to provide for private industry a technical and economic prospectus on the possibilities of exploiting the country's rich and immense oil-shale reserves. In coking and gasification studies, progress was made on two processes which promise a cheap source of materials for various purposes. In the first, carbon monoxide of relatively high purity was produced by burning pitch coke or petroleum coke with oxygen. In the second, the nation's immense reserves of lignite were brought closer to industrial use through the successful testing of a large retort for producing carbon monoxide and hydrogen from lignite by gasification. At the same time, greater production and a more uniform grade product were obtained without increased capital or labor costs at several coke plants using the bureau's data on coal bulk-density control.

—Excerpt from Article

2. APPLIANCES - DOMESTIC AND COMMERCIAL

AIR CONDITIONING

Tanzola, W.A. AIR CONDITIONING SYSTEMS AND THEIR CHEMICAL TREATMENT. *Southern Power and Industry* 64, 60-63 *(1946) February.*

A good review is presented of the problems arising in connection with cooling water and spray water of air conditioning systems. The chief problem is the proper treatment of the water to insure against scale formation, corrosion, and the fouling of heat transfer surfaces by organic growths. Appropriate chemical treatment to prevent each of these troubles is suggested.

--M.F. Knoy

KITCHEN VENTILATION

A STUDY OF VARIOUS METHODS OF KITCHEN VENTILATION. *Amer. Gas Assoc. Testing Laboratories Research Bulletin 40 (1946).*

Four types of kitchen ventilation systems studied show that it is possible to remove at least 50% of the heat produced by operations of a gas range, and under certain conditions as high as 70%. Moisture produced by cooking can be removed up to 98%. Air withdrawal rates necessary to remove indicated percentages of heat and moisture are not in excess of 400 cu. ft. per min. Cooking odors can be confined to the kitchen in most instances or diluted to an acceptable degree in adjacent rooms with reasonable rates of air withdrawal. Deposition of cottonseed oil in ventilating systems in the form of vapor or smoke was found to be very slight in tests conducted to date. Larger particle sizes or droplets of grease however, if once carried into the system, will accumulate therein.

3. COMBUSTION AND INDUSTRIAL FURNACES

FLAME-TEMPERATURE MEASUREMENTS

Uyehara, O.A., Myers, P.S., Watson, K.M. and Wilson, L.A. FLAME-TEMPERATURE MEASUREMENTS IN INTERNAL-COMBUSTION ENGINES. *Trans. Am. Soc. Mech. Eng.* 68, 17-30 *(1946) January.*

The theory, development, and calibration of an electro-optical pyrometer, capable of determining instantaneous true temperatures of luminous flames, are described. A description is also given of auxiliary apparatus used with the electro-optical pyrometer to obtain simultaneous values of pressures, temperature, and crank position in an internal-combustion engine. Typical data obtained with this instrumentation as applied to a Diesel engine are included.

HEAT IN COMBUSTION GASES

Rosin, P.O. TOTAL, RECOVERABLE AND RETURNABLE HEAT IN COMBUSTION GASES. *J. Inst. Fuel* 19, 53-61 *(1945) December.*

Combustion gases are an industrial raw material, whose utilization is achieved by means of heat transfer from the hot gases to another body. The value of this raw material depends on its temperature, heat content, also on heat emissivity and certain chemical properties, such as oxidizing and reducing capacity. Whether the transfer of heat is direct, as in the blast furnace, open hearth or heat-treatment furnaces, or indirect, as in coke ovens or steam boilers, the basic purpose is the production per unit time of a definite amount of hot gases at a specified temperature. A combustion gas is the carrier of heat energy, of which it is partly deprived during the process of industrial heating. The resultant "cooled-down gas" is a waste product whose economic value depends on the amount of residual sensible heat it carries and the feasibility of recovering it. The author discusses in detail the fundamental questions respecting the recovery of heat from waste gases: How much heat is contained in the waste gas per unit time, both as Btu per hour and as a percentage of the fuel consumption per hour? How much of this heat is recoverable and returnable?_____In order to obtain the answer it is first necessary to calculate the volume of combustion products. The method presented for this is based on statistical relations between the net calorific value of the fuel used, the excess air employed and the volume of the combustion products, the latter being calculated from the former two data. The excess air can be readily calculated from the CO_2 content of the waste gases, secondly, the heat content of the waste gases at any given temperature must be determined. This can be done very advantageously by making use of the so called "It" charts, proposed by Rosin and Tehling in 1929, in which the heat content of the waste gas in Btu per cu. ft. is plotted versus the percent air in the combustion gas (or products) for temperatures ranging from 100-1600°C. Finally, a method is presented for the calculation of the total, recoverable or returnable heat in waste gases from the volume and heat content of the combustion products (gases), using the data obtained in the first and second steps.

--J.J.S. Sebastian

CARBONIZATION

Edwards, H.D. THE UTILIZATION OF WASTE HEAT IN HIGH TEMPERATURE CARBONIZATION PROCESSES. *Brit. Coal Util. Res. Assoc. Monthly Bull.* 9, 333-8 (1945) *December.*

The thermal efficiency, defined as the proportion of the thermal energy entering the process recovered in the form of products (gas, coke, tar, etc.) for sale, is 85% for some modern gas works carbonizing plants, and 87-88% for some of the plants equipped with modern regenerative ovens, The balance, namely 15% of the weight of coal carbonized in the former case and 12-13% in the latter, is used to generate the producer gas to heat the retorts or ovens. The carbonizing process is almost thermally neutral for most coals. The overall heating efficiency for an intermittent vertical retort setting is 61.6% as compared to 74.1% for a coke oven, the balance of 38.4 and 25.9%, respectively, not being returned to the heating process. Heat is dissipated from a carbonizing plant using non-recuperative retorts in the form of sensible heat in (a) the flue gases (45.3%), (b) the coke (30.2%), and (c) the vaporized distillation products (16.3%), the remainder of 8.2% being lost by radiation and convection from the walls, or because of inefficient operation,----------. In modern plants a large part of these heat losses are eliminated by efficient methods of heat recovery. The sensible beat in the flue gases is recovered in recuperators (in gas retorts or small ovens), in regenerators (in large coke ovens), and in waste heat boilers used in conjunction both with retorts and ovens. In some coke oven plants the rich gas is diluted prior to combustion with recirculated flue gases. For maximum heating efficiency, as much of the sensible heat as possible should be returned to the system, making use of the waste heat boilers only as a last resort. It is estimated that in modern gas works the average steam requirement is 1000 lb. per ton of coal carbonized. With improved heat recovery only a part of the steam required would be supplied by waste heat boilers, the balance to be generated in separate boilers fired with coke breeze. The latter procedure is more efficient to generate the steam required,----------. The sensible heat in coke may be recovered by using it to preheat the combustion air, or in steam generation by the dry-cooling processes. Part of the steam thus generated may be used for "steaming" of vertical retorts and, to a lesser extent, of coke ovens. However, the final temperature of the coke should not be allowed to fall below 1450° F. The steaming of coke ovens does not appear to be practiced as a method of waste heat utilization, except where it is desired to increase the output of the gas at the expense of coke production. The Sulzer and Collin dry-cooling systems, replacing the old fashioned, quenching with water, made possible substantial savings of the sensible heat in coke and also a reduction in the breeze produced. In both of these processes inert gases derived from the reaction between air and the hot coke are recirculated up through the latter, down through a boiler, and thence back to the fan. The difference in the two processes lies in the method of handling the coke after discharge from the oven. Approximately 900-1100 lb. of steam per ton of coke cooled may thus be generated. In 1942 there were two gas works and five coke oven plants provided with Sulzer type dry-cooling equipment in Britain,----------. The sensible heat in volatile matter leaving the retorts or coke ovens has not yet been utilized. The heat

thus lost with the gases leaving a coke oven at about 1400° F amounts to over 2% of the calorific value of the coal charged. The possibility of using metallic heat-exchangers for this purpose should be investigated. ---------. The fact that the heat required for carbonization is a minimum when the moisture content of the coal is 8% is believed to be related to the swelling of the coal which is a minimum when 8-14% moisture is present. Waste heat thus cannot profitably be used to reduce the moisture content of coal for carbonization to less than 8%.

--J.J.S. Sebastian

COKING

Armistead, G. Jr. THE COKING OF HYDROCARBON OILS. *Oil & Gas J.* 44, 103-111 *(1946) March 16.*

Delayed coking is one important process for conserving petroleum to give maximum ultimate yields of motor fuel by both catalytic and thermal processes. It is also a good means for disposing of fuel oils and heavy residues when market conditions for them are unfavorable. It is competitive with viscosity breaking and cracking, with higher yields.

GAS PURIFICATION

Shaw, J.A. GAS PURIFICATION PROCESS. *U.S. 2,395,509 February 26, 1946.*

A cyclic process for removing organic sulphur from gas, comprising: scrubbing the gas with a scrubbing medium containing morpholine to dissolve organic sulphur from said gas and form a morpholine sulphur complex; removing scrubbing medium from contact with said gas and extracting so-separated medium with a solvent for morpholine sulphur complex that is immiscible with scrubbing medium; removing so treated medium from contact with said solvent and recycling the medium with a predetermined morpholine concentration to the gas scrubbing step; reacting the separated solvent with an acidic-reactant material to release organic sulfur from morpholine sulphur complex by formation of a new morpholine salt with said acidicreactant material; passing therethrough an inert gas to remove organic sulphur from the morpholine salt; reacting residual morpholine salt with alkali to release free morpholine; separating the free morpholine and recycling it to the scrubbing medium introduced into the gas-scrubbing step.

SULFUR REMOVAL

Wood, J.W. and Claydon, E.W. SURVEY OF THE DISTRIBUTION OF ORGANIC SULPHUR COMPOUNDS IN TOWN GAS. Key, A. and Eastwood, A.H. REMOVAL OF SULFUR COMPOUNDS FROM COAL GAS AND SYNTHESIS GAS. *Gas Times* 65, *34-36 (1945) December 22.*

Dr. H. Hollings pointed out that analysis of organic sulfur compounds should not be limited by narrow geographical areas. The relative value of catalytic methods and removal processes depended too much on precise nature of the compound. It was found that carbon disulfide was responsible for the greater part of the total organic sulfur content of most gases. Mr. Wood suggested that thiophene "might have a not unexpected relationship with the degree of cracking and production of aromatic hydrocarbons." Symptomatic changes of products resulted with cracking conditions. An alarming and unexplained discrepancy of carbon

oxysulfide content of blue water gas and that of carburetted water gas was observed. Also, Mr. Wood pointed out that catalytic processes for removal of CS_2 from coal gas could give rise to mercaptan synthesis. The report indicated experiments showed COS could not be appreciably removed by oil washing or active carbon recovery plant being too volatile. Mercaptan could be removed about 50% with a low removal of thiophene. Removal of CS_2 by oil washing requires three times as much oil as for benzene because of the volatility of CS_2. The catalyst copper oxide and chromium oxide at 250° reduced organic sulfur content of coal gas from 15 grains to 0.3 grain per 100 cubic feet and with steam the efficiency was increased even for water gas. Repeated treatment results in effective removal but proves expensive. Effective catalysts described were copper sulfide, chromium oxide, and molybdenum. The uses of either are attended by certain critical limitations. The article further concluded that equilibria data being incomplete to date, catalytic information depended on further studies.

—E.M. Rueck

5. NATURAL GAS AND NATURAL GAS CONDENSATES

GAS DEHYDRATION

DIETHYLENE GLYCOL PLANT DEHYDRATES GAS TO EXACT SPECIFICATION. *Petroleum Refiner* 25, 67-68 (1946) February.

A description of the process and equipment used in dehydrating 15,000,000 cubic feet of gas daily for the city of Long Beach, California. The wet gas is contacted by diethylene glycol in a 4 tray contractor, the mixture is extracted and the gas sent to lines leading to city gas holders. The diethylene glycol from the base of the contactor is renewed in a 16 plate fractionating column. The loss of diethylene glycol is said to be negligible. Operating conditions and flow rates are given.

RESERVES, ESTIMATION

Barnett, D.G. OIL AND GAS RESERVE ESTIMATION CHARTS. *Oil Weekly* 121, 22-24 (1946) March 4.

The charts are based on productive area, average thickness of reservoir sand, effective porosity which is the gross porosity minus the allowance for connate water, and the pressure under which the gas exists, commonly taken as the well-head shut-in pressure.

--Excerpt from Article

6. PETROLEUM AND SYNTHETIC LIQUID FUELS

BUTADIENE MANUFACTURE

Russell, R.P., Murphree, E.V. and Asbury, N.C. THE PRODUCTION OF BUTADIENE BY THE DEHYDROGENATION OF NORMAL BUTYLENES. *Trans. Am. Inst. of Chem. Engrs.* 42, 1-14 *(1946) February 25.*

The advent of fluid catalytic cracking gave rise to a large supply of C_4 olefins which could advantageously be utilized in producing butadiene after the attach on Pearl Harbor. The use of steam as a heat carrying diluent in the dehydrogenation was evident but known dehydrogenation catalysts were permanently deactivated by steam. A steam and sulfur resistant catalyst (not disclosed) was developed and has been successfully used in commercial plants. The usual system is two reactors, one of which is on-stream while the other is undergoing regeneration by removal of carbon with steam. Preheaters were designed to preheat the butylene feed to about 1100° F while steam was heated to 1300° F or more. The ratio of steam to butylene was about 10 to 1. Total pressure on the reactor is about 5 psi gauge. The reactors are 16 feet in internal diameter and catalyst bed depth was finally set at 42 inches. The life of catalyst before replacement has averaged 75 days in commercial operation. Cost of the butadiene plants vary from $250 to $480 per ton per year of finished butadiene capacity. The extreme range of butadiene costs are from 6 to 12.5¢ per. lb. (including 10% depreciation).

—C.H. Riesz

CYCLE STOCKS

Brown, C.L., Voorhies, A., Jr. and Smith, W.N. CYCLE STOCKS FROM CATALYTIC CRACKING. *Ind. Eng. Chem.* 38, *136-140 (1946) February.*

Hydrogenation of the aromatic constituents in refractory, catalytically cracked, cycle stocks to their corresponding naphthene derivative results in improved catalytic-cracking feed stocks which are superior even to the original virgin gas oils. Higher conversions are obtained under similar cracking conditions; less carbon and more gasoline result for a given degree of cracking. Gasoline octane numbers are at least as good as those obtained with virgin feed stocks. Hydrogenation conditions used are generally the same as for the conventional high-pressure destructive hydrogenation of gas oils directly to gasoline except for the catalyst which, similarly, is sulfur-resistant. Yields of hydrogenated cycle stock are 100% or more in all cases, with little change in boiling range and virtually complete sulfur removal. A combination of catalytic cracking with hydrogenation of all cycle stock and recracking to ultimate gasoline yield combined with fullest utilization of light hydrocarbons (C_3, C_4, C_5) by isomerization, alkylation, etc., is shown by calculation to result in an over-all volumetric yield of over 90% of 100-octane gasoline. Lower pressures (750 compared to 3000 lb. sq. in. gage) result in partial saturation of aromatics with rather complete desulfurization.

—Author's Abstract

6. PETROLEUM AND SYNTHETIC LIQUID FUELS

ETHYLENE RECOVERY

Pratt, A.W. and Foskett, N.T. LOW TEMPERATURE PROCESSING OF LIGHT HYDROCARBONS. *Trans. Am. Inst. of Chem. Engrs.* 42, 149-163 (1946) February 25.

The design and operation of a typical olefin recovery plant designed for the production of 95% pure ethylene is presented. Cracked gases are purified from hydrogen sulfide after a single compression stage and then are compressed to 600 psi and cooled to 70° F. After moisture removal with activated bauxite or alumina, the gases are cooled to 0° F and introduced to the demethanization distillation tower for removal of hydrogen and methane. Reflux temperature is about -130° F. The bottoms from this tower flow to the ethylene tower (400 psi, 50-60 trays) where reflux is supplied at -15° F. Bottoms from this column are ethane and heavier components which may be further processed or recycled to the cracking furnace. Problems involved in dehydration (gas must have a dew point of -100° F), refrigeration, materials of construction and instrumentation are discussed.

—C.H. Riesz

GASOLINE

Armistead, G.Jr. CATALYTIC CRACKING FOR PRODUCTION OF MOTOR GASOLINE. *Oil & Gas J.* 44, 60-3, 81-82 (1946) March 2.

The petroleum industry now has catalytic cracking equipment taking 1,100,000 bbl. per calender day of feed capacity. This is about 25% of current crude runs. The gasoline production is between 500,000 and 600,000 bbl. per calender day of cracked gasoline and is around 65-75% of maximum peacetime production of thermally cracked motor gasoline. Catalytic cracking has a higher direct operating cost than thermal cracking but other factors give catalytic cracking an economic advantage. These factors include high quality of motor or aviation fuel produced and usability of higher boiling range and high sulfur feed stocks. Correlations of operating conditions with product yields and distribution are presented. The effect of recycle on gasoline and carbon yields is also discussed. Synthetic catalyst appears to have wider application than natural catalysts. 20 references.

—C.H. Riesz

GASOLINE

Armistead, G., Jr. MODERN REFINING PROCESSES. FACTORS AFFECTING QUALITY OF MOTOR GASOLINE FROM CATALYTIC CRACKING OF GAS OILS. *Oil & Gas J.* 44, 76-83 (1946) March 9.

The various factors which affect the quality of catalytically cracked gasoline are summarized in a table. Important factors are discussed in detail. Octane numbers of motor gasolines obtained from paraffins feed stocks are lower than those produced in catalytic cracking of naphthenic stocks. The octane ratings range from 79 to 82 which is to be compared with a corresponding variation of from 55 to 75 obtained in thermal cracking. The sulfur content of the feed stock largely controls the sulfur content of the motor gasoline with consequent effects on clear octane and lead susceptibility; other factors such as the type and nature

of the feed stock and contained sulfur compounds are also involved. The effect of operating conditions on gasoline quality is complicated; in general, higher reactor temperature gives higher clear octane numbers, the increase being greater when the gasolines are rated by the C.F.R. Research method. Improved octane characteristics of gasoline are produced by cracking with synthetic catalyst in comparison with natural catalyst. A ratio of 0.25 to 0.50 recycle to fresh feed increases the clear octane numbers one to two units.

--C.H. Riesz

HEPTANE RECOVERY

Griswold, J. and Van Berg, C.F. PURE HYDROCARBONS FROM PETROLEUM. *Ind. Eng. Chem.* 38, 170-177 (1946) February.

The Distex process has been applied to the separation of a narrow-boiling heptane fraction (Skellysolve C) from mid-continent natural gas, and pure n-heptane has been prepared by two operations. The Distex pilot plant and its performance are described at different reflux ratios in separating the heptane fraction into paraffinic, naphthenic, and aromatic portions. Pure heptane was obtained from the paraffinic portion by batch fractionation.

--Author's Abstract

ISOMERIZATION

McAllister, S.H., Ross, W.E., Randlett, H.E., and Carlson, G.J. THE LIQUID PHASE ISOMERIZATION OF NORMAL PARAFFINS USING A FLUID SALT CATALYST. *Trans. Am. Inst. Chem. Engr.* 42, 33-53 (1946) February.

The article describes in detail a commercial liquid phase catalytic process for the isomerization of light saturated petroleum hydrocarbons at moderate temperatures. The catalyst is a molten salt mixture consisting of anhydrous aluminum chloride dissolved in antimony trichloride together with hydrogen chloride. The process is carried out in an entirely continuous manner employing continuous rejection of spent aluminum chloride and continuous catalyst make-up so that the catalyst is maintained at a constant high level of activity and a uniform product is thus obtained. The method of operation is outlined and a flow diagram showing the major pieces of equipment is presented along with a discussion of construction materials. The required feed specifications and the effects of the principal reaction variables, i.e, temperature, aluminum chloride concentration, hydrogen chloride concentration, catalyst to feed phase ratio, and the hydrocarbon residence time are given for butane and pentane isomerization. Typical average results from commercial isomerization of these two hydrocarbons are also presented. The possible application of this process to the isomerization of hexane fractions is summarized briefly.

PLASTICS FROM PETROLEUM

Penn, W.S. PLASTICS FROM PETROLEUM. *Petroleum* 9, 41 (1946) February.

An account of the relationship between the petroleum, plastics, and synthetic rubber industries is given. It includes discussions on the need for plastics, their uses, and methods of application, and describes the

production of plastic materials from petroleum. The importance of using scientifically-controlled petroleum fractions is emphasized, and statistics are given. The need for energetic action-to acquire large markets-on the part of the petroleum industry is shown, and conclusions reached which indicate the vast opportunities available to petroleum in competition with coal and agricultural products. In the second article of this series, the general manufacturing methods of plastics will be discussed, and in the third article, the production of plastics from petroleum.

--Author's Abstract

7. ANALYTICAL METHODS AND TESTS

INFRA-RED ANALYSIS

Fray, D.L., Nusbaum, R.E., Randall, H.M. THE ANALYSIS OF MULTICOMPONENT MIXTURES OF HYDROCARBONS IN THE LIQUID PHASE BY MEANS OF INFRA-RED ABSORPTION SPECTROSCOPY. *J. Applied Phys.* 17, 150-161 (1946) March.

This is a general method of applying infra-red absorption spectroscopy to the analysis of multicomponent hydrocarbon mixtures in the liquid phase. The procedure is calibrated by measuring optical densities of synthetic standard samples. A constant thickness cell is used for both standard and unknown samples. Two procedures for converting optical densities to concentrations are described. Examples are given for four-and five-component mixtures. Data are presented to show the reproducibility of repeated measurements of optical density on the same sample, and results are given to show the agreement between the infra-red analyses and the known composition of synthetic mixtures.

MASS SPECTROMETRY

Young, W.S. APPLICATIONS OF THE MASS SPECTROMETER TO REFINERY PROCESS CONTROL. *Natl. Petroleum News* 38, 212-219 (1946) March 6.

This "how-to do-it" article is based on more than 8000 analyses of hydrocarbon mixtures by mass spectrometry-the main application of this relatively new type of laboratory apparatus. Pioneering in the use of mass spectrometry for process control purposes in petroleum refining, the author's company has found the instrument adaptable to operation on a routine basis for such applications as: fractionation, where analysis of overhead products constitutes one of the simplest analytical problems; cracking, where the instrument is used to evaluate the potential availability of the gas stream to other plant operations; alkylation, polymerization, and other applications. For adaptability to mass spectrometer analysis, hydrocarbon mixtures are classified in two groups: those directly suitable; and those which must first undergo low-temperature fractionation to remove compounds not determinable by mass-spectrometry or to concentrate certain components. Special operating techniques are described; and suggestions are given for the operation and maintenance of the apparatus.

--Author's Abstract

MODERN TECHNIQUES

IDENTIFYING HYDROCARBON MIXTURES. *Oil & Gas J.* 44, 66-69 (1946) March 9.

Modern techniques useful in identifying and analyzing hydrocarbon mixtures are based on the use of ultraviolet and infra red rays, X-ray diffraction, electron diffraction, surface-area measuring equipment and a wide variety of physical and electrical apparatus for determining various properties of oils and catalysts, such as dielectric constants, porosities, freezing points, etc. Some specific applications of these methods in the U.O.P. laboratories are described briefly.

8. GENERAL AND PHYSICAL CHEMISTRY

AMMONIUM NITRATE-AMMONIA-WATER

Shultz, J.F. and Elmore, G.V. THE SYSTEM AMMONIUM NITRATE–AMMONIA–WATER. *Ind. Eng. Chem.* 38, 296–298 (1946) March.

The total vapor pressures of solutions in the system ammonium nitrate–ammonia–water were measured at 10° and 35° C., the vapor phases were analyzed by a thermal conductivity method, and the corresponding partial pressures of ammonia and water were calculated. The experimental compositions contained from 5 to 30% ammonia and from 0 to 75% ammonium nitrate. The densities of the solutions were determined at 35° C.

CARBON DIOXIDE, THERMODYNAMIC PROPERTIES

Sweigert, R.L., Weber, P., and Allen, R.L. THERMODYNAMIC PROPERTIES OF GASES. CARBON DIOXIDE. *Ind. Eng. Chem.* 38, 185–200 (1946) February.

A Mollier diagram covering the range of −75° to 1800° F. over a range of specific volumes of 0.1 to 1000 cu. ft. per lb. for pressures up to 3000 lb. per sq. in. is presented, based on the work of Plank and Kuprianoff and on data obtained by the authors. A maximum error of not over 5% at the highest pressures and less than 2% at pressures below 1500 lb. per sq. in. is claimed. A compressibility factor chart is presented with reduced temperature and pressure as variables and also with ordinary temperature and pressure as variables. Calculations are based largely on the Plank and Kuprianoff equation of state and on the Sweigert and Beardsley heat capacity equation. They are respectively:

$$V = 0.2437\,\frac{T}{P} - \frac{(1.32 + 1.3794 \times 10^{-3}P)}{(T/180)^{1073}}$$

and $$C_P = 16.2 - \frac{6.53 \times 10^3}{T} + \frac{1.41 \times 10^6}{T^2}$$

The latter equation is based on statistical thermodynamic data. The units to be employed are as follows: Btu per (lb. mole x R) for C_P, lb. per sq. in. for P. °R or T and cu. ft. per lb. for V.

—J.D. Parent

DETOXICATION OF CARBON DISULFIDE

Maxted, E.B. and Marsden, A. STUDIES IN THE DETOXICATION OF CATALYST POISONS. PART IV. DETOXICATION OF CARBON DISULPHIDE. *J. Chem. Soc.* 1946, 23–27, *January.*

The catalytic toxicity of small concentrations of carbon disulfide in a hydrogenation system, catalyzed by platinum black, was suppressed by addition of hydrogen peroxide. Complete detoxification was obtained by the use of permolybdic or perphosphoric acid in the presence of an excess of hydrogen peroxide. An increased detoxication effect is obtained by adding the reagents in more than one increment. It is necessary to apply a preliminary hydrogenation before addition of reagent. An intermediate hydrogenation product is probably formed which is oxidized and the electron octets of the sulfur atoms, become completely shared, thereby shielding the toxic sulfur atoms.

—C.H. Riesz

9. ORGANIC CHEMISTRY

BENZENE AZEOTROPES

Marschner, R.F. and Wendell, P.C. HYDROCARBON AZEOTROPES OF BENZENE. *Ind. Eng. Chem.* 38, 262-267 (1946) March.

The azeotropic behavior of benzene in admixture with ten nonaromatic hydrocarbons has been investigated, and the entire boiling range of the hydrocarbons with which benzene forms azeotropes at atmospheric pressure has been established. Collectively, the data argue that the azeotropic behavior of benzene is more pronounced, the higher the hydrogen-carbon ratio of the second hydrocarbon component. Benzene is a much weaker azeotrope-forming substance than is ethanol, with which saturated hydrocarbons of nearly four times the boiling point spread form azeotropes. Fractionation data are presented to indicate the limitations imposed by the presence of benzene upon analytical hydrocarbon fractionation, but the usefulness in certain cases of benzene as an azeotropic agent is also demonstrated. Correlations are developed by means of which the compositions and boiling points of uninvestigated benzene-nonaromatic hydrocarbon azeotropes may be estimated.

BUTENE-1, THERMODYNAMIC PROPERTIES

Aston, J.G., Fink, H.L., Bestul, A.B., Pace, E.L. and Szasz, G.J. THE HEAT CAPACITY AND ENTROPY, HEATS OF FUSION AND VAPORIZATION AND THE VAPOR PRESSURE OF BUTENE-1. THE ZERO POINT ENTROPY OF THE GAS. THE ENTROPY OF THE GAS FROM MOLECULAR DATA. *J. Am. Chem. Soc.* 68, 52-57 (1946) January.

Butene-1 has been crystallized for the first time. The heat capacities of crystalline butene-1 have been measured from 11° K. to the melting point; of butene-1 gas, from 12.5 to 78° K.; of the liquid, from the melting point (87.32° K.) to normal boiling point. The solid-liquid equilibrium temperature and heat of fusion have been determined. The vapor pressures have been determined from 199 to 267° K. and the results represented by an equation leading to a value for the normal boiling point. The heats of vaporization have been determined from 202 to 267° K. and a quadratic equation derived to represent them. Vapor densities have been measured at 298.16° K.

BUTENE-1, VOLUMETRIC BEHAVIOR

Olds, R.H., Sage, B.H. and Lacey, W.N. VOLUMETRIC BEHAVIOR OF 1-BUTENE. *Ind. Eng. Chem.* 38, 301-303 (1946) March.

The volumetric and phase behavior of 1-butene was experimentally determined at temperatures from 100° to 340° F. and at pressures up to 10,000 pounds per sq. in. The results of these measurements were found to correlate well with those of other investigators.

CYCLOPENTANES, THERMODYNAMIC PROPERTIES

Douslin, D.R. and Huffman, H.M. THE HEAT CAPACITIES, HEATS OF TRANSITION, HEATS OF FUSION AND ENTROPIES OF CYCLOPENTANE, METHYLCYCLOPENTANE AND METHYLCYCLOHEXANE. *J. Am. Chem. Soc.* 68, 173-176 (1946) February.

Heat capacity data on cyclopentane, methylcyclopentane and methylcyclohexane have been given over the range 12 to 300° K. Values of the melting point and temperatures of transition have been given. The heats

of fusion and transition were determined. Entropy values for the liquid state at 298.16° K. were calculated.

DEHYDROISOMERIZATION OF BUTANE

Bloch, H.S. and Schaad, R.E. DEHYDROISOMERIZATION OF n-BUTANE. *Ind. Eng. Chem.* 38, 144-147 (1946) February.

The conversion of n-butane into a mixture of n-butylenes and isobutylene has been carried out at atmospheric pressure with a catalyst comprising a dehydrogenating component (chromia-alumina) and an olefin-isomerizing component (silica-alumina-thoria). A catalyst bed composed of a mixture of granules of the two components was much more effective than a bed of granules made of the mixed powders. Under the most favorable conditions (525-575° C., gaseous hourly space velocities of 500-1200), butylene yields of 25-30% were obtained with a dehydrogenating efficiency of approximately 85%. About one fourth of the yield of butylene was isobutylene.

—Author's Abstract

ETHYLBENZENE, THERMODYNAMIC PROPERTIES

Scott, R.B. and Brickwedde, F.G. THERMODYNAMIC PROPERTIES OF SOLID AND LIQUID ETHYLBENZENE FROM 0° TO 300° K. *J. Research Natl. Bureau Standards* 35, 501-513 (1945) December.

The following properties of a sample of high purity ethylbenzene were measured: (1) Specific heat of solid and liquid from 15° to 300° K; (2) triple-point temperature (-95.005 ± 0.010° C for pure ethylbenzene); (3) heat of fusion (86.47 int. j g-1); (4) heat of vaporization at 294° K (400.15 int. j g^{-1}); and (5) vapor pressure from 273° to 296° K. With these experimental data, the enthalpy and entropy of the solid and of the liquid in the range 0° to 300° K were calculated.

HEPTANES, BOILING POINT

Fawcett, F.S. BOILING POINTS OF THREE ISOMERIC HEPTANES. *Ind. Eng. Chem.* 38, 338-340 (1946) March.

Boiling points of 2,2-dimethylpentane, 2,4-dimethylpentane, and 2,2,3-trimethylbutane have been determined by the comparative dynamic method over the range 1-15 atmospheres, using n-heptane as the reference liquid.

ISOBUTANE SYNTHESIS

Grummitt, O., Case, E.N. and Mitchell, C.V. CONVERSION OF n-HEPTANE TO ISOBUTANE. *Ind. Eng. Chem.* 38, 141-144 (1946) February.

Experiments with water-or hydrogen chloride-promoted aluminum chloride and n-heptane, with and without the addition of sodium, magnesium, or aluminum, have been run at 95-100° C. and atmospheric pressure to determine the yields of isobutane, light paraffins (C_5-C_7), heavy paraffins (C_8 and higher), and the oil from the catalyst complex. These metals exert a very marked influence on the promoted catalyst as shown by decreased conversions, increased isomerization to light paraffins, and decreased cracking-isomerization to isobutane and oil. Because aluminum

has the greatest effect in retarding oil formation, which inactivates the catalyst, it is the best of the three metals tested for controlling this reaction as a route to the production of isobutane and of light paraffin hydrocarbons.

—Author's Abstract

METHANE, THERMODYNAMIC PROPERTIES

Matthews, C.S. and Hurd, C.O. THERMODYNAMIC PROPERTIES OF METHANE. *Trans. Am. Inst. Chem. Engrs.* 42, 55-78 *(1946) February.*

The thermodynamic properties of methane have been developed from the most reliable basic data selected after critical study of all available experimental values. These properties are presented, both as a tabulation and a pressure-enthalpy diagram, for conditions ranging from saturated liquid and vapor at -280° F. to superheated vapor at 500° F. and 1,500 lb./sq. in. abs. The compilation includes values for vapor pressure, specific volume, enthalpy, latent heat, entropy, and the fugacity/pressure ratio.

PARAFFIN-HYDROGEN FLUORIDE SYSTEMS

Butler, C.E., Miles, C.B. and Kuhn, C.S. HYDROGEN FLUORIDE-PARAFFIN SYSTEMS. *Ind. Eng. Chem.* 38, 147-155 *(1946) February.*

Mutual solubilities of low-molecular-weight hydrocarbons (isobutane, n-butane, propane) and of hydrogen fluoride in two liquid phase systems, with and without water and alkylate, were determined for the range 0-50°C., with alkylate concentrations up to 30 weight % in the hydrocarbon phase, and water contents up to about 10 weight % in the acid phase. Anomalous solubilities of isobutane in the presence of alkylate and water are considered to be related to the greater alkylating activities of isoparaffins. Tentative correlations of the data with analyses of plant streams are presented.

—Author's Abstract

PROPYLENE

PROPYLENE IN CHEMICAL INDUSTRY. *Petroleum* 9, 30 *(1946) February.*

Propylene can be derived either from coal or from petroleum. The gaseous products of coal-carbonization processes contain small amounts of propylene in addition to 1-2% of ethylene. The percentage of propylene in general is not known with any accuracy, but is of the order of 0.2-0.5% by volume of the gas. The total quantity present in the gas produced by the town's gas and coke-oven industries is therefore of the order of 100,000 tons per annum. The other possible source of propylene is from the gases produced during the cracking and reforming operations practised in the petroleum industry. These gases contain some propylene and considerable proportions of propane; the latter is readily dehydrogenated to propylene at elevated temperatures and in the presence of suitable catalysts. In 1942, the potential amount of propylene producible from refinery gases throughout the world was about two million tons per annum. Ethylene is an especially important starting material for chemical synthesis, largely because of its molecular simplicity combined with its high reactivity. Propylene is useful because it

contains three carbon atoms and can readily be made to provide valuable compounds containing this number of atoms-as, for example, glycerol and acetone. A diagram shows the main uses to which propylene may be put.
--Excerpt from article

10. CHEMICAL ENGINEERING

COAL GRINDABILITY

Brown, R.L. THE GRINDABILITY OF COAL. *Brit. Coal Utilization Research Assoc. Monthly Bull.* 10, 1-10 (1946) January.

It is declared that the U.S. ball-mill and Hardgrove machine grindability tests lead to reproducible results on the same coal, but that they lead to anomalous values of ease of grinding in some cases. Tests show that resistance to grinding is not necessarily associated with commonly measured physical properties such as hardness or ease of crushing. Further different methods of size reduction depend upon different characteristics. Methods of crushing coal depend on either or both of the following: (1) shattering by impact or crushing loads or (2) disintegration after deformation caused by shearing forces and attrition. It is felt that grindability research has been hindered by the physical complexity of industrial processes and by a lack of appreciation of the physical structure of coal.

--J.D. Parent

COMPRESSIBILITY

Jacobson, E.W., Ambrosius, E.E., Dashiell, J.W. and Crawford, C.L. COMPRESSIBILITY OF LIQUID HYDROCARBONS. *Oil & Gas J.* 44, 109-110 (1946) *March 23.*

A rather good correlation is obtained for the compressibility of oils as a function of gravity in °A.P.I. Curves are presented. The oils tested include lube oils, aviation gasoline, LP-gas and some pure hydrocarbons.

FLOW RATE

Miller, B. CALCULATION OF THROUGHPUT. *Oil and Gas J.* 44, 64-65 (1946) *March 2.*

The author presents methods of calculating the flow rate when several liquids having different properties are flowing simultaneously through a pipe line. This is particularly applicable to products which may contain LP-gases, several grades of gasoline, kerosene, and distillate fuel oil.

FRACTIONATION

Edmister, W.C. MULTICOMPONENT FRACTIONATION DESIGN METHOD. *Trans. Am. Inst. Chem. Engr.* 42, 15-32 (1946) *February.*

A new method is presented for making the theoretical plate and component distribution calculations required in the design of multicomponent fractionation equipment. This method consists of applying new fractionation equations to both enriching and stripping sections of the fractionator, for an assumed number of theoretical trays and reflux, to find the concentration changes for the distributed components and then estimating the distillate and bottom products by combining the results at the feed plate. The effects of temperature gradient and variations in molal overflow may be taken into consideration by using effective absorption and stripping factors, defined as functions of terminal conditions only, or by using the absorption and stripping factors for each plate in the series form of the equations.

10. CHEMICAL ENGINEERING

HEAT TRANSFER LIQUID

APPLICATION OF HIGH TEMPERATURE LIQUID AS A HEAT OR ENERGY TRANSFER MEDIUM. *Gas Age* 97, 40 (1946) February 21.

It is stated that O.O Oaks speaking before the recent 52nd Annual Meeting of the A.S.H.V.E. anticipated that in a few years it may be entirely practicable to use a single fuel burning device for all of the usual purposes. A heat transfer liquid of promise is tetracresyl silicate which boils near 800° F and freezes at 65° F below zero.

SUPER EXPANSIBILITY

Adams, G.R. NATURAL GAS SUPER-EXPANSIBILITY METER FACTORS. *Oil Weekly* 121, 42-45 (1946) March 18.

The subject of gas measurement accuracy is discussed. The following statements are made: (a) The thickness of the pipe can be determined to within 0.1%. (b) The orifice plate can be machined to within about 0.1%. (These two factors are needed for the calculation of the basic flow factor). (c) A change of 1° F in meter run temperature introduces an error of 0.1%. (d) The specific gravity factor is the most important term. Liquid spray behaves in such a manner as to make the gas have a higher effective or composite gravity. The presence of spray limits the accuracy of measurements to within 1%. (e) Errors in differential readings limit accuracy to within 1% for a 10" scale. A longer scale is recommended. (f) Errors in the range of 0.1 to 1% may be encountered due to inaccuracy in the calibration or reading of pressure gages. A set of curves for a particular natural gas is presented based on the compressibility factor curves of G. G. Brown published in the Clark Brothers reprint "Deviations of Natural Gas from the Heat Gas Laws". "Compressibility factor μ, is defined by the equation $PV = \mu RT$ ——— (1) where P is the absolute pressure V is the molar volume, R is the universal gas constant. T is the absolute temperature, and $\frac{1}{\mu}$ is called Y, the "expansibility factor". The super-expansibility factor of the orifice meter equation is $\sqrt{Y}$. The curves presented in the article are for $\sqrt{Y}$ for different pressures and temperatures and for a natural gas of gravity 0.664.

—J.D. Parent

VAPOR PRESSURE-TEMPERATURE NOMOGRAPHS

Lippincott, S.B. and Lyman, M.M. VAPOR PRESSURE-TEMPERATURE NOMOGRAPHS. *Ind. Eng. Chem.* 38, 320-323 (1946) March.

Nomographs are presented that give vapor pressure-temperature relations for compounds boiling from 50° to 550° C. If any two of the three related quantities, vapor pressure, temperature, and normal boiling point, are known, the third can be found by a single setting of a straight edge.

12. MATERIALS OF CONSTRUCTION

HIGH TEMPERATURE ALLOY

Marande, R.F. MAGNESIUM-CERIUM ALLOY CASTINGS FOR HIGH TEMPERATURE USE. *Materials & Methods* 23, 418-424 (1946) February.

Properties at elevated temperature indicate magnesium-cerium alloys can be used for pistons and other parts.

HYDROFLUORIC ACID CORROSION

Friend, W.Z. and Teeple, H.O. CORROSION BY HYDROFLUORIC ACID. *Oil & Gas J.* 44, 87-101 (1946) March 16.

This article records results of laboratory and plant corrosion tests in hydrofluoric acid of various concentrations. The results enable summarization with considerable accuracy, of the suitable fields of applications, and limitations, of common metals and alloys in processes involving hydrofluoric acid.

—Author's Abstract

PIPELINES

Oldt, L.M. MAGNESIUM GIVES HIGH CATHODIC PROTECTION TO PIPELINES AND BURIED STRUCTURES. *Natl. Petroleum News* 38, 186-187 (1946) March 6.

Underground pipelines and metal structures are being guarded against corrosion by expendable magnesium anodes buried in the nearby soil and employing the principle of cathodic protection. Greatly increased equipment life is predicted. For example, a flume built of steel piling driven 14 ft. into the earth was expected to withstand corrosion for only five years. Magnesium anodes installed for cathodic protection have extended that life expectancy for an indefinitely long period. Certain magnesium alloys, as described in this article, have been found to offer superior properties as galvanic anodes for this type of protection. When properly installed, as much as 500 ampere hours of electricity have been realized per pound of magnesium consumed on the anode, compared, for example with 373 ampere hours for a zinc anode. Longer life and efficiency of the magnesium anodes havd been achieved by developing new types of backfill-the electrolyte used around the anode.

—Author's Abstract

13. NEW BOOKS

Mawhinney, M.H. THE HEATING OF STEEL. *New York, Reinhold Publishing Corp., 1945.*

The book has chapters on Chemical Effects of Heating Steel, Fuels and Burner Equipment, Temperature Distribution and Furnace Control, Heat Transfer and Fuel Economy, The Quenching of Steel, Alloys and Refractories, and Steel Mill Furnace.

PERIODICALS ABSTRACTED FOR GAS ABSTRACTS

AMERICAN ASSOCIATION FOR ADVANCEMENT OF SCIENCE BULLETIN

AMERICAN GAS ASSOCIATION MONTHLY

AMERICAN GAS JOURNAL

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JOURNAL OF CHEMICAL PHYSICS

JOURNAL OF CHEMICAL SOCIETY (LONDON)

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JOURNAL OF THE INSTITUTE OF PETROLEUM

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